Focal mechanism solutions using Waveform Inversion: A new catalogue for Ecuador

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The complex tectonics of the northern Andes are controlled by the interaction of the Nazca, South America and Caribbean plates. The oblique convergence of the Nazca plate below South America induces 1) high stress accumulation, mainly in the northern margin, 2) drift of the North Andean Sliver (NAS) to the northeast (Nocquet et al., 2014), through the dextral Chingual-Cosanga-Pallatanga-Puná (CCPP) fault system in Ecuador (Alvarado et al., 2016), and 3) stress accumulation along secondary fault systems, primarily within the Andes. Historically, the megathrust and other intraplate faults have hosted destructive earthquakes within the Ecuadorian territory, hence the importance in properly characterizing seismic sources. The recently improved national broadband seismic network (Alvarado et al., 2018) allows us to carry out wider studies based on waveform inversion, such as focal mechanism determination. In this study, we construct a new Ecuadorian focal mechanism catalogue for earthquakes with magnitudes 3.5 Mw and larger by applying the MECAVEL algorithm to waveforms from three-component broad band seismic stations (e.g., 2011; Grandin et al., 2017). This significantly increases the number of solutions compared to the Global CMT (generally over 5.0 Mw) and IG-EPN solutions based on first arrival polarities. We obtain an improved image of tectonic sources by combining the MECAVEL and GCMT solutions, gaining better insight into deformation along and around both principal and secondary faults. For example, the strike-slip character of the Puná fault predicted by GPS appears more clearly defined. Along the plate margin, primarily thrusting focal mechanisms in Northern Ecuador reflect the high inter-seismic coupling as derived from GPS. By contrast, fault planes in Central and Southern Ecuador have more variable orientations, and coincide with low-to-moderate predicted coupling. We interpret this dichotomy as due to heterogeneous deformation in the slab and upper crust, rather than as a control by a locked interface. At depth, normal focal mechanisms are a response to slab pull, with nodal planes governed by the deep morphology of the slab. The value of this catalogue lies in its appreciable contribution to fault geometry characterization and the improved probabilistic hazard determination it will enable.

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